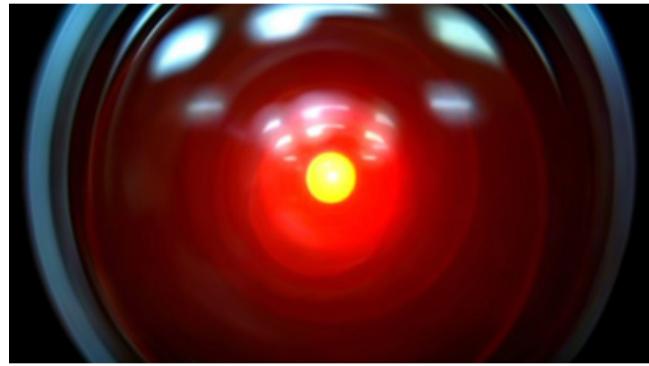
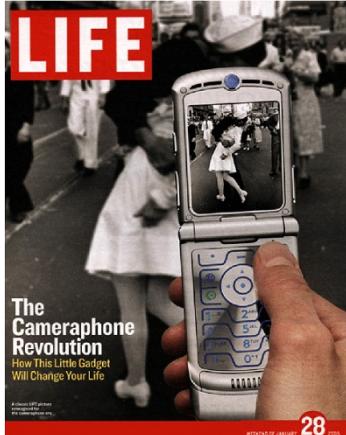


Lecture: Introduction to Computer Vision

Juan Carlos Niebles and Ranjay Krishna

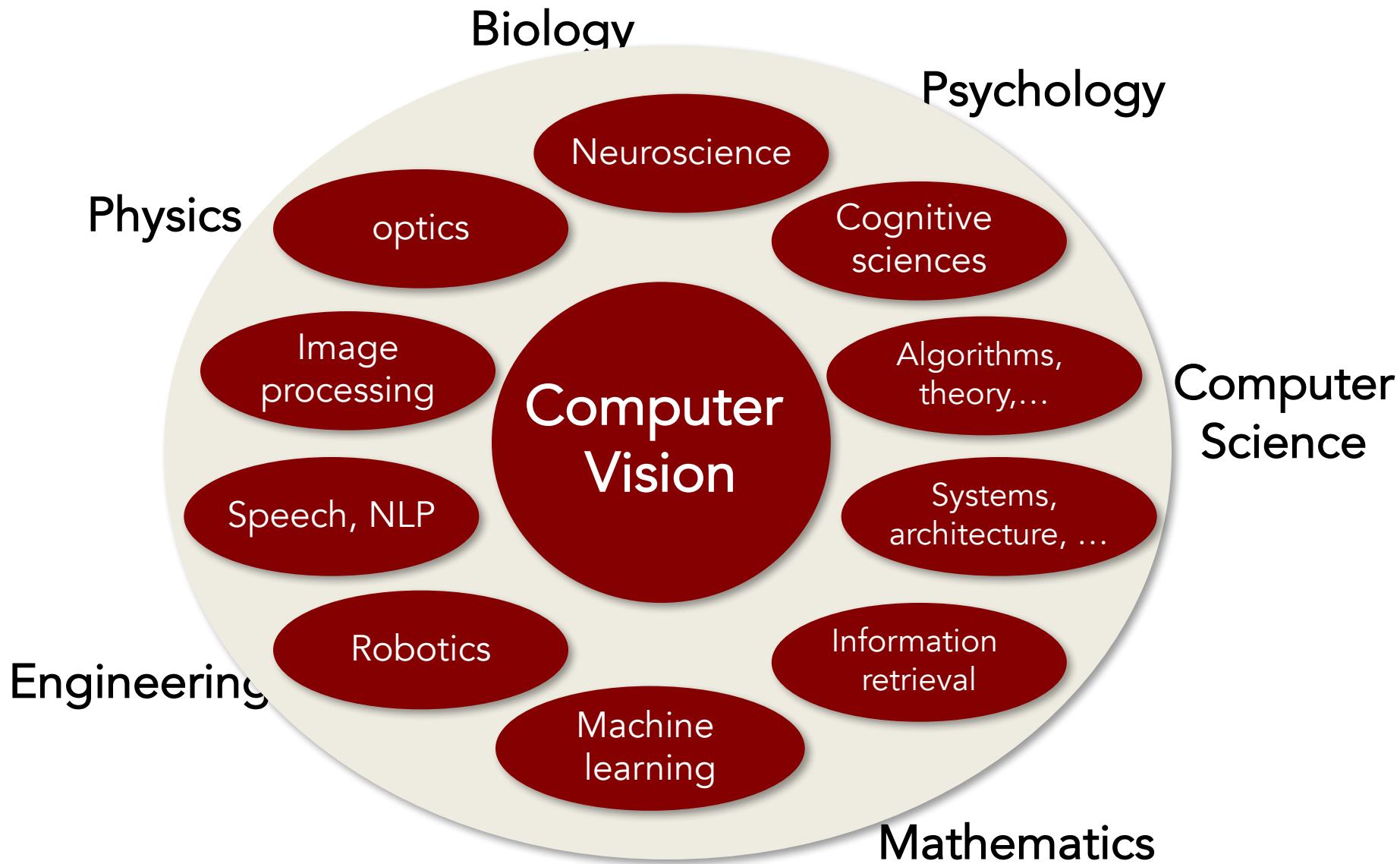
Stanford Vision and Learning Lab

Welcome to CS131



CS131 is the introductory course for computer vision

- CS131 (fall, 2017):
 - Enthusiastic undergrads
 - Want to get to know this exciting technology
 - Pre-req to more advanced vision classes
- CS231a (winter, 2018, Prof. Silvio Savarese)
 - Advanced Computer Vision
 - Seniors, masters, and PhDs
- CS231n (spring, 2018): Deep Learning and Convolutional Neural Networks



Today's agenda

- Introduction to computer vision
- Course overview

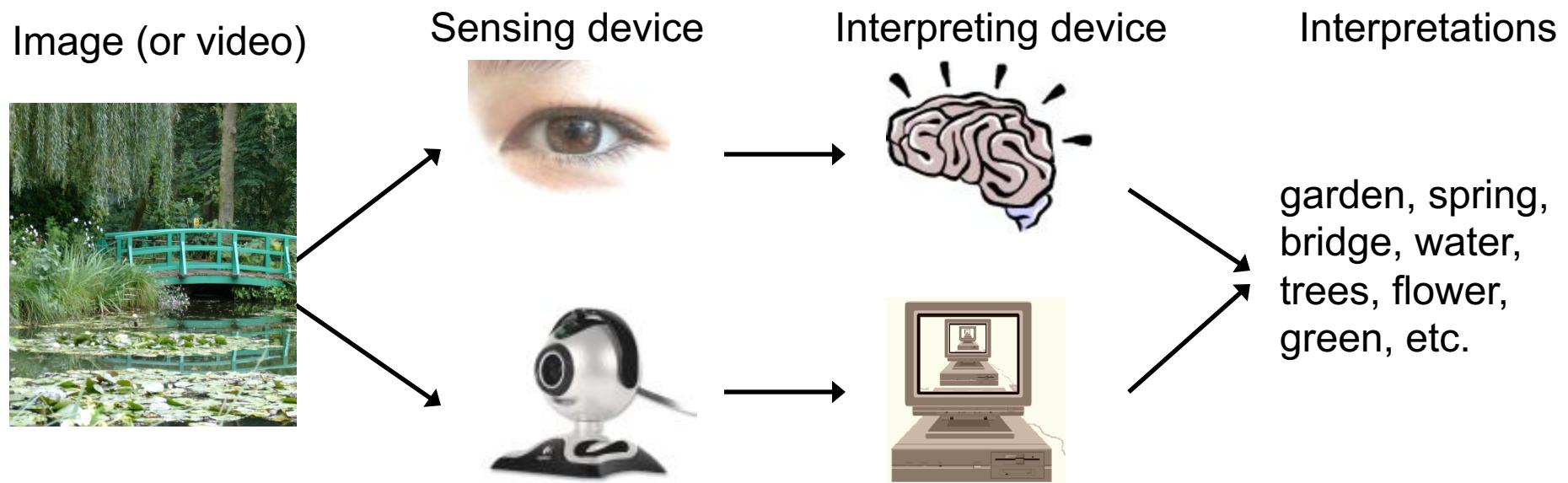
Quiz?



What about this?



What is (computer) vision?



The goal of computer vision

- To bridge the gap between pixels and “meaning”

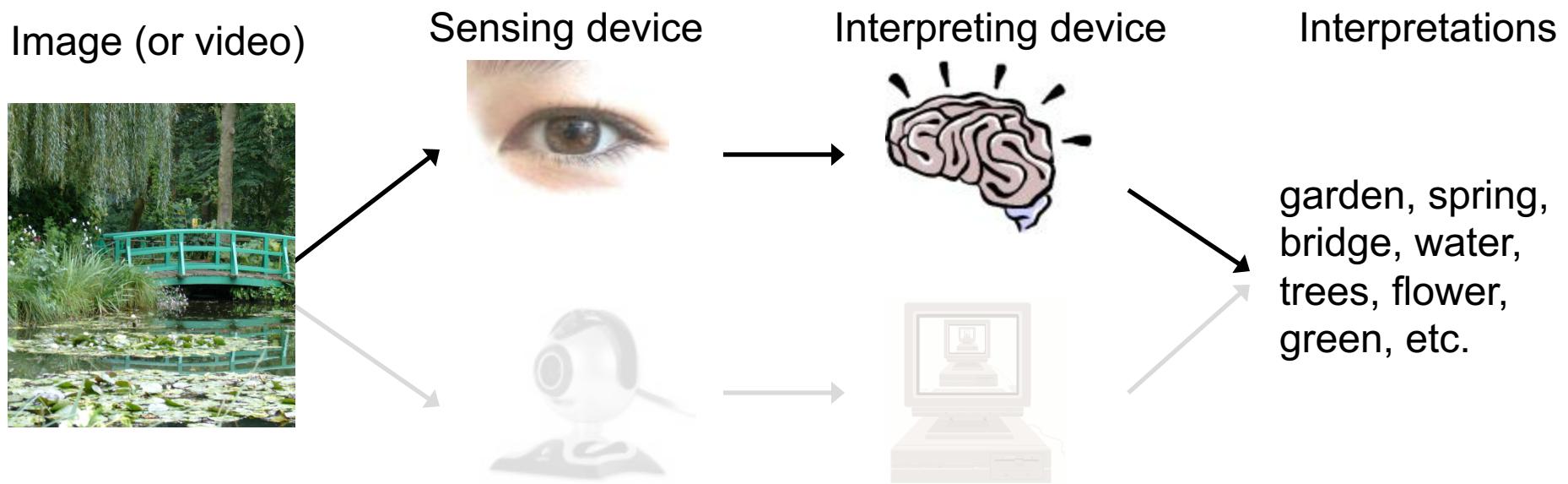


What we see

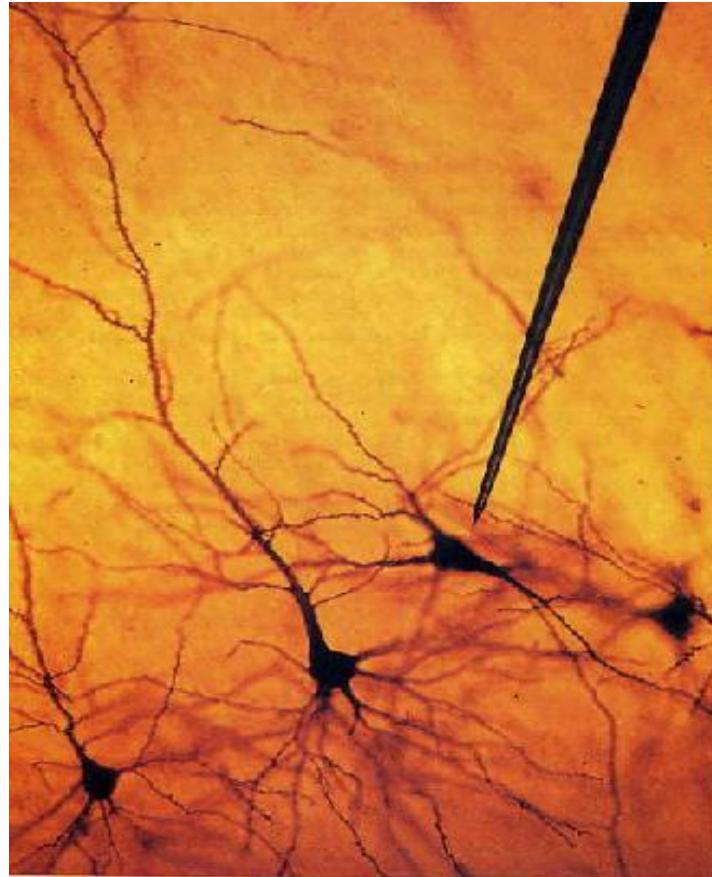
0	3	2	5	4	7	6	9	8
3	0	1	2	3	4	5	6	7
2	1	0	3	2	5	4	7	6
5	2	3	0	1	2	3	4	5
4	3	2	1	0	3	2	5	4
7	4	5	2	3	0	1	2	3
6	5	4	3	2	1	0	3	2
9	6	7	4	5	2	3	0	1
8	7	6	5	4	3	2	1	0

What a computer sees

What is (computer) vision?



1981: Nobel Prize in medicine



Hubel & Wiesel

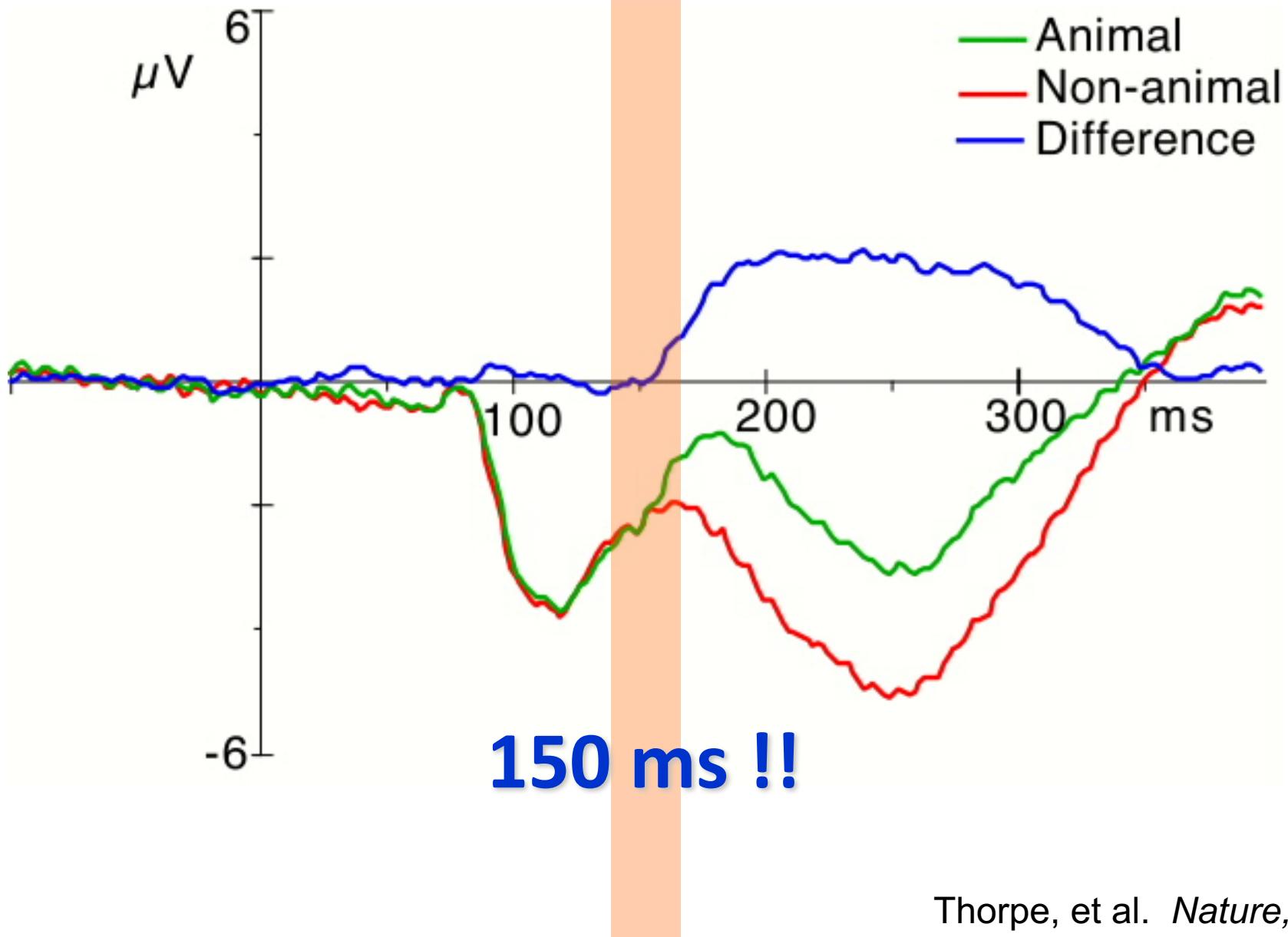
Human vision is superbly efficient



Potter, Biederman, etc. 1970s



Thorpe, et al. *Nature*, 1996



Thorpe, et al. *Nature*, 1996

Change blindness



Rensink, O'regan, Simon, etc.

Change blindness



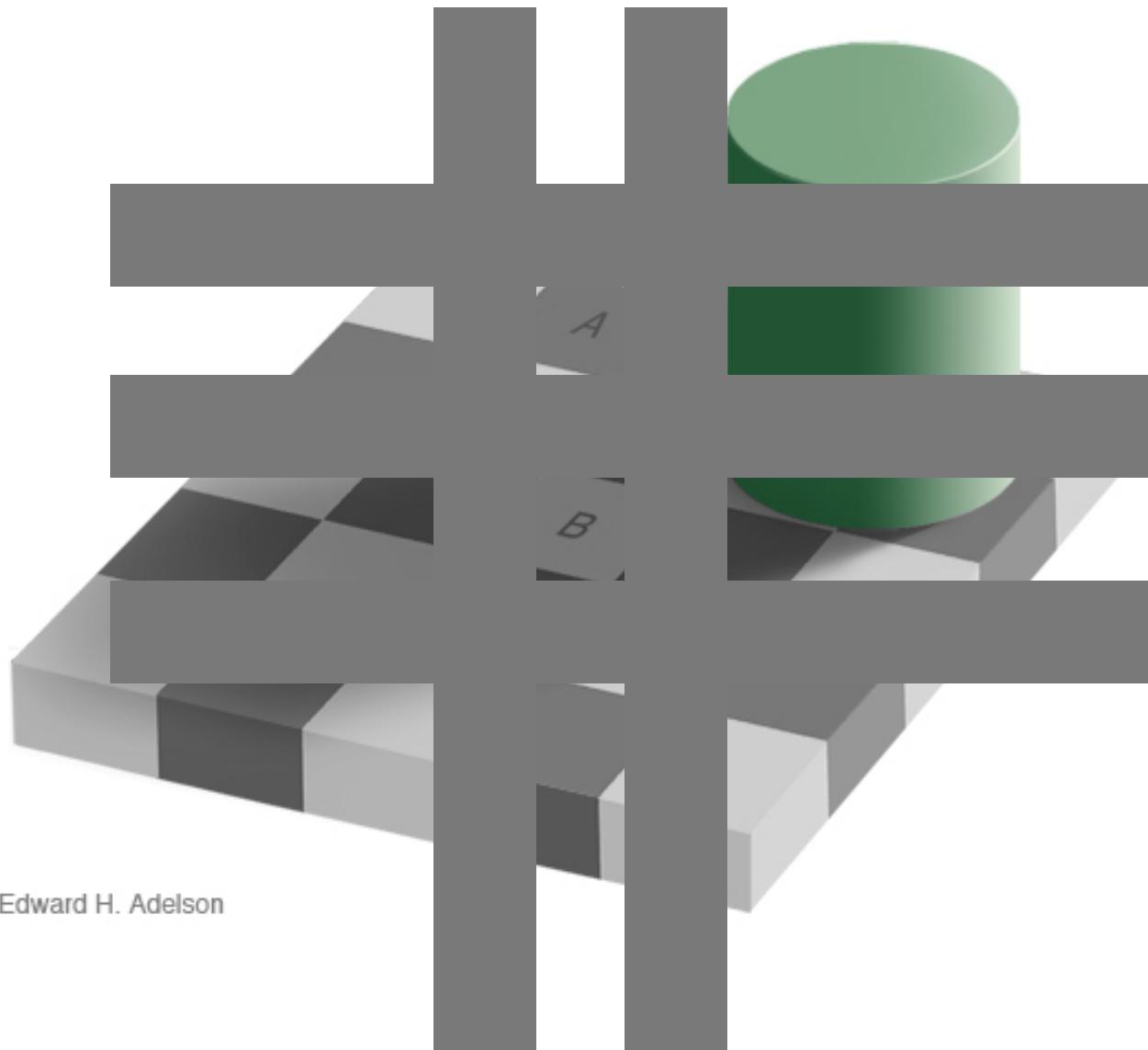
Rensink, O'regan, Simon, etc.

segmentation



Perception

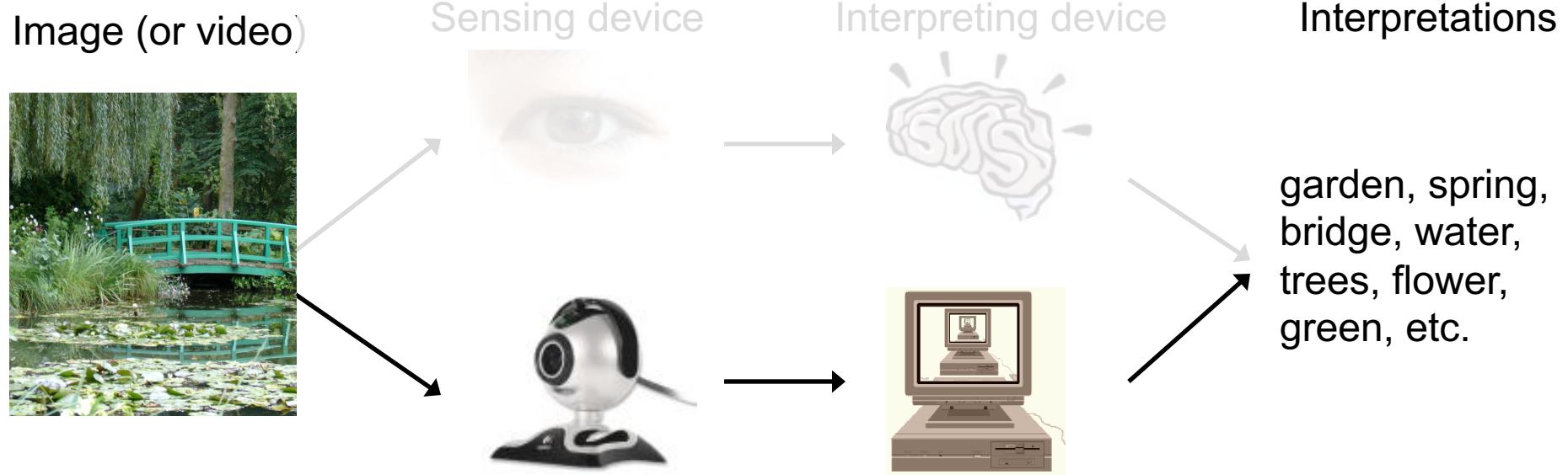




Edward H. Adelson



What is (computer) vision?



The goal of computer vision

- To bridge the gap between pixels and “meaning”

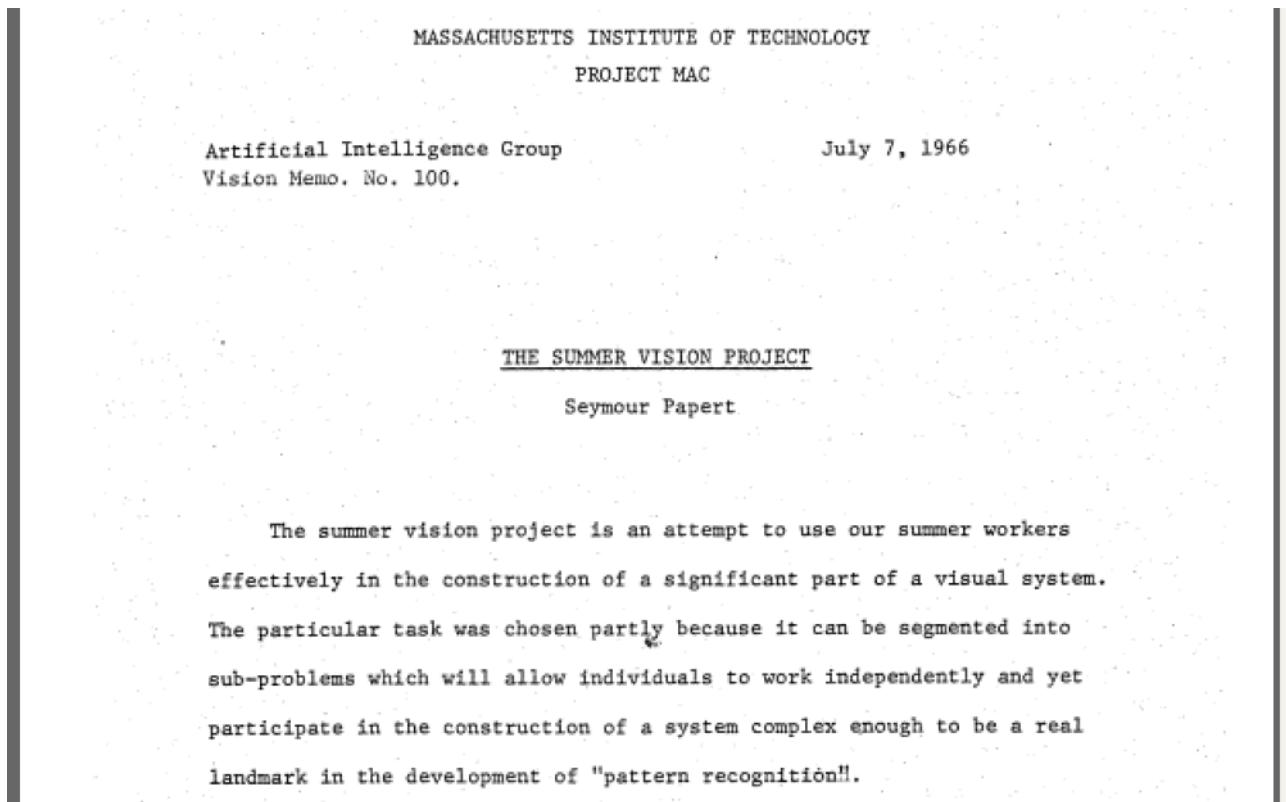


What we see

0	3	2	5	4	7	6	9	8
3	0	1	2	3	4	5	6	7
2	1	0	3	2	5	4	7	6
5	2	3	0	1	2	3	4	5
4	3	2	1	0	3	2	5	4
7	4	5	2	3	0	1	2	3
6	5	4	3	2	1	0	3	2
9	6	7	4	5	2	3	0	1
8	7	6	5	4	3	2	1	0

What a computer sees

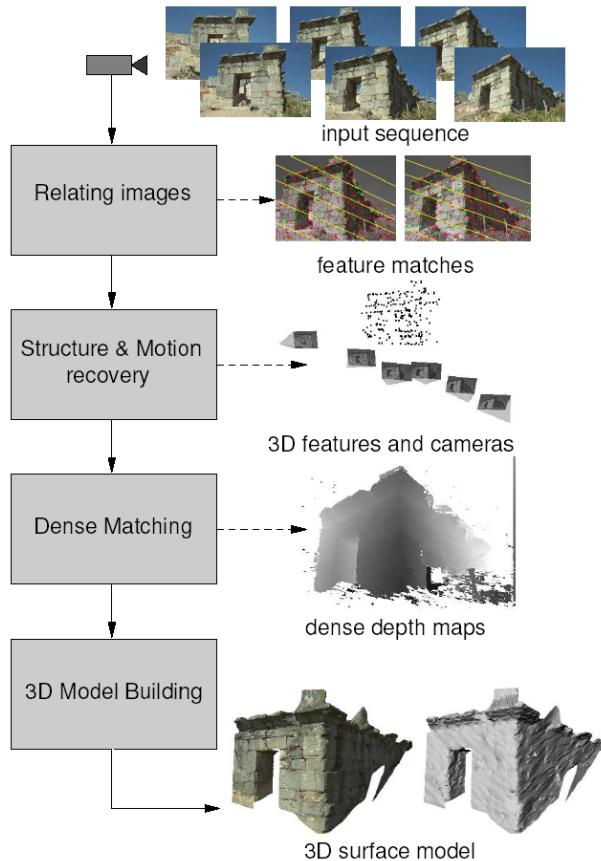
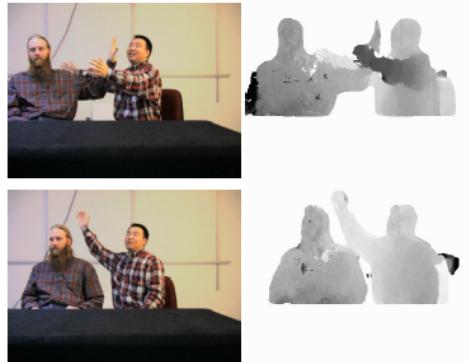
Origins of computer vision: an MIT undergraduate summer project



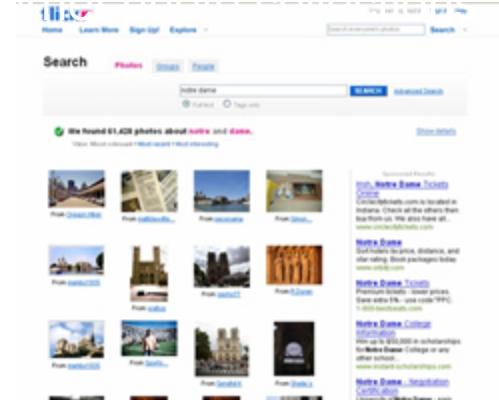
What kind of information can we extract from an image?

- Metric 3D information
- Semantic information

Vision as measurement device

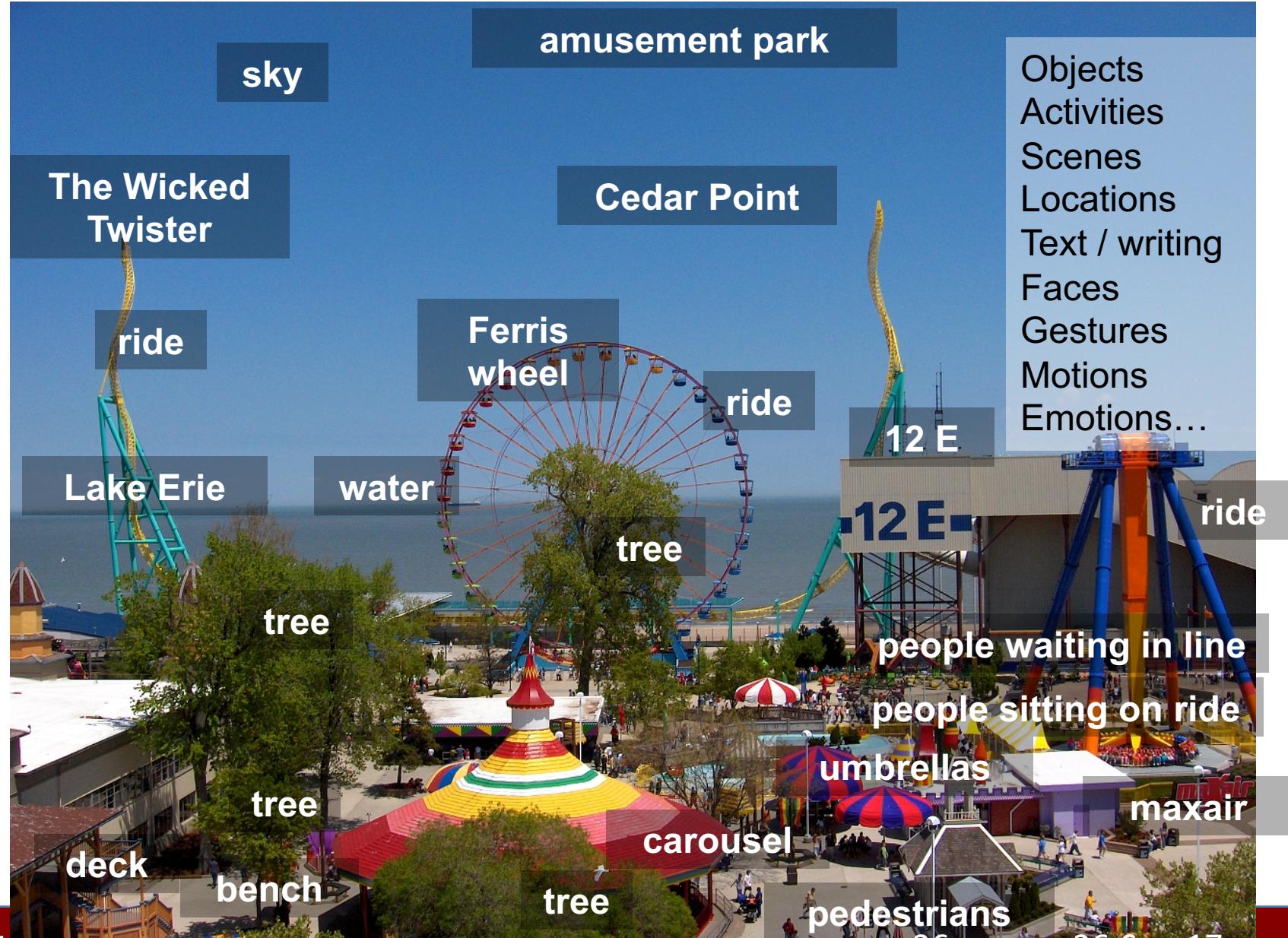


Pollefeys et al.



Goesele et al.

Vision as a source of semantic information

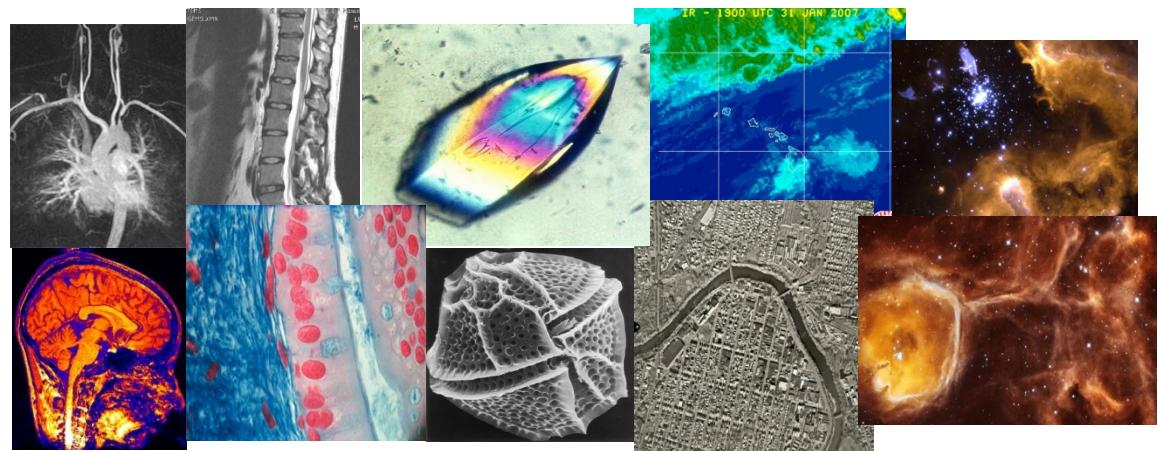


Why study computer vision?

- Vision is useful: Images and video are everywhere!



Surveillance and security



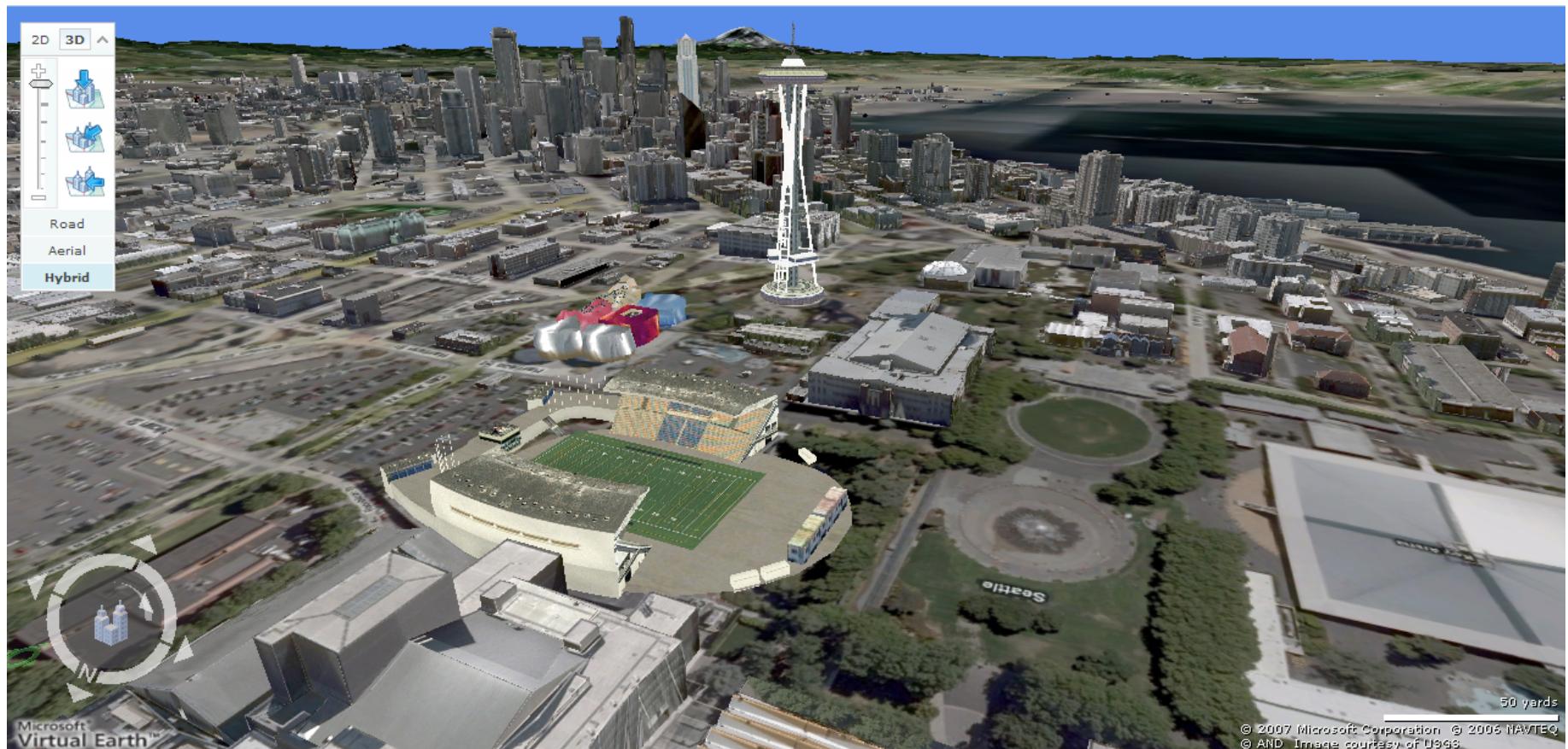
Medical and scientific images

Special effects: shape and motion capture



Source: S. Seitz

3D urban modeling



Bing maps, Google Streetview

Source: S. Seitz

3D urban modeling: Microsoft Photosynth



<http://photosynth.net>

Source: S. Seitz

Face detection



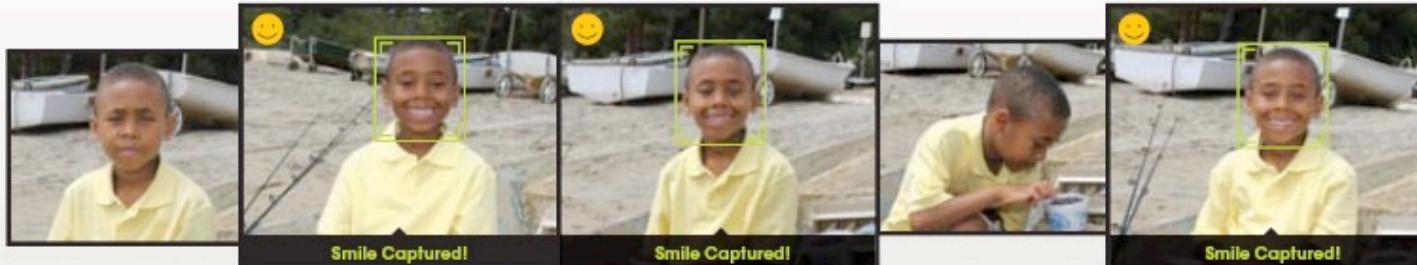
- Many digital cameras now detect faces
 - Canon, Sony, Fuji, ...

Source: S. Seitz

Smile detection

The Smile Shutter flow

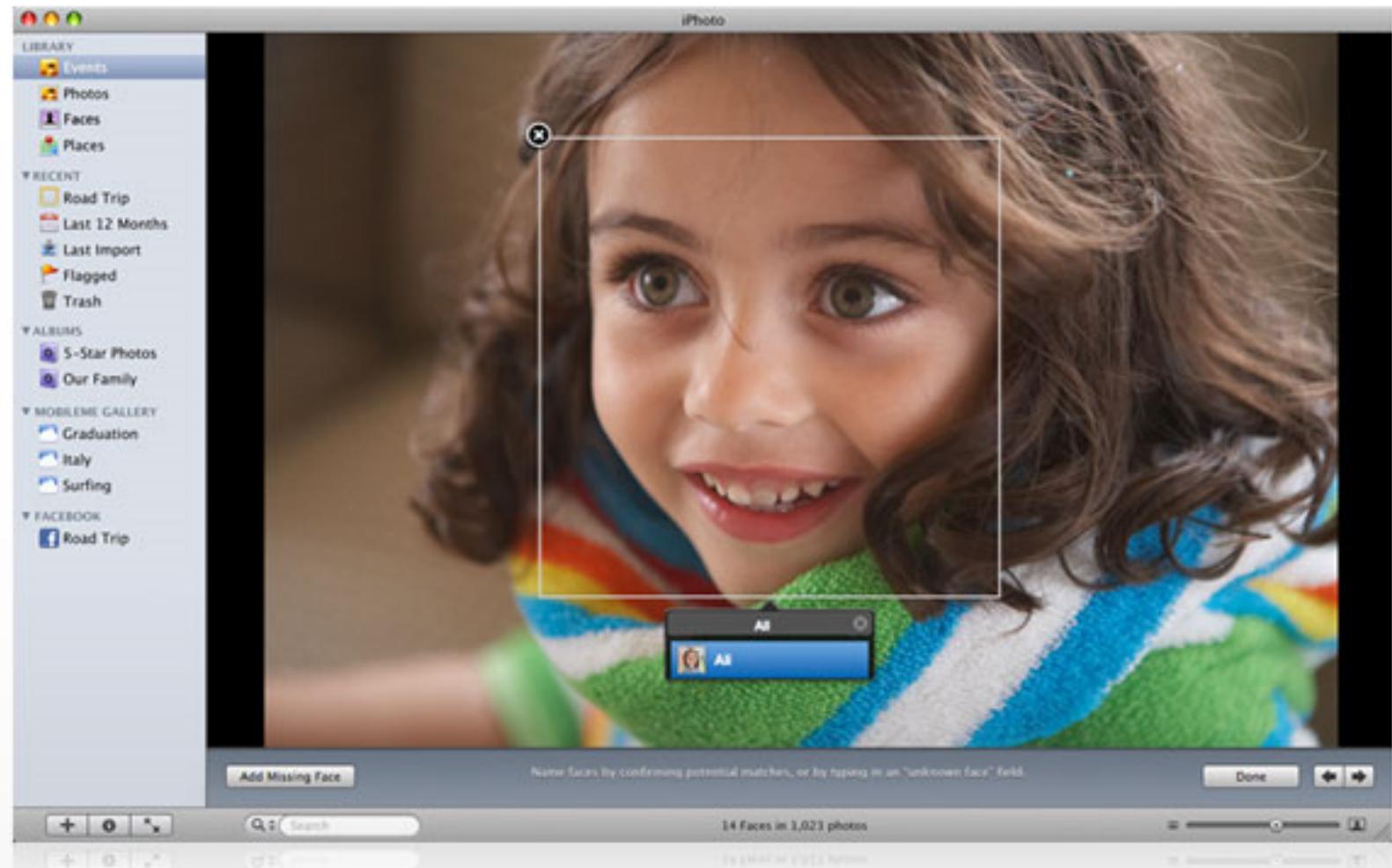
Imagine a camera smart enough to catch every smile! In Smile Shutter Mode, your Cyber-shot® camera can automatically trip the shutter at just the right instant to catch the perfect expression.



[Sony Cyber-shot® T70 Digital Still Camera](#)

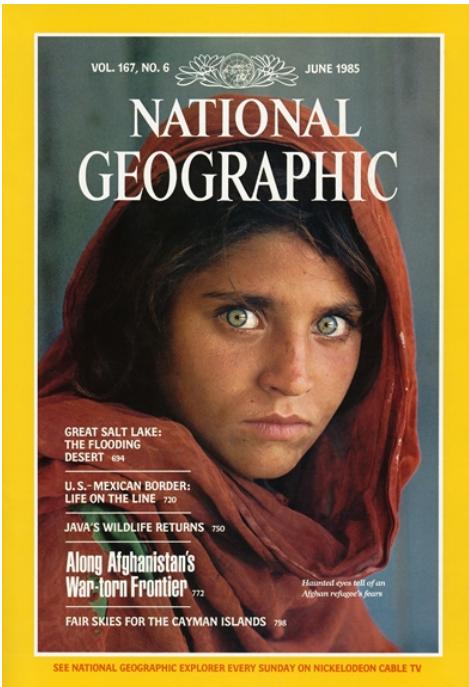
Source: S. Seitz

Face recognition: Apple iPhoto software

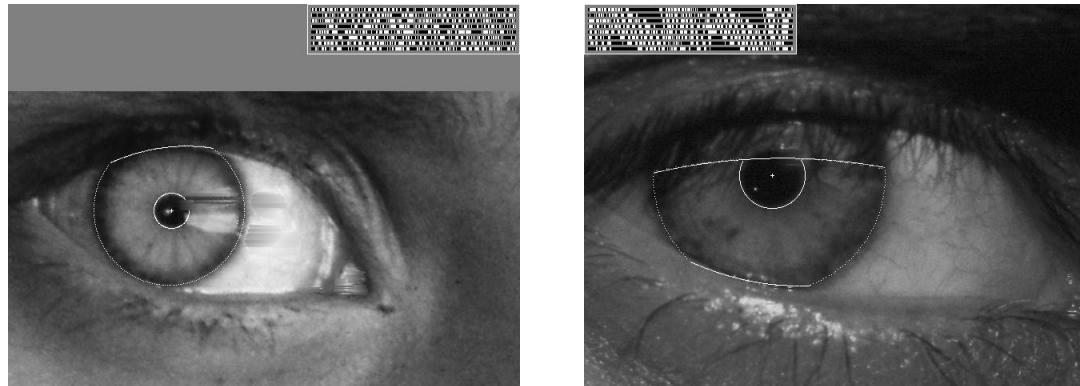


<http://www.apple.com/ilife/iphoto/>

Biometrics



How the Afghan Girl was Identified by Her Iris Patterns



Source: S. Seitz

Biometrics



Fingerprint scanners on
many new laptops,
other devices

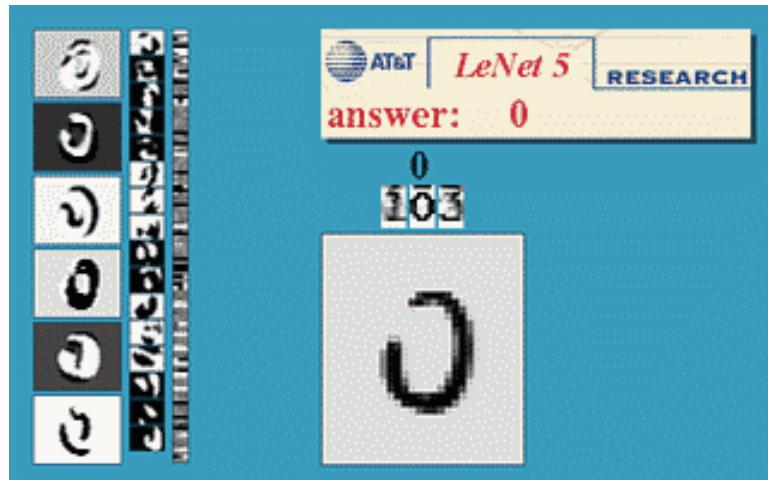


Face recognition systems now beginning
to appear more widely
iphone X just introduced face recognition

Optical character recognition (OCR)

Technology to convert scanned docs to text

- If you have a scanner, it probably came with OCR software



Digit recognition, AT&T labs



License plate readers

http://en.wikipedia.org/wiki/Automatic_number_plate_recognition

Source: S. Seitz

Toys and Robots



Mobile visual search: Google Goggles

Google Goggles in Action

Click the icons below to see the different ways Google Goggles can be used.



[Landmark](#)



[Book](#)



[Contact Info.](#)



[Artwork](#)



[Places](#)



[Wine](#)



[Logo](#)



The search results page shows the following information:

Wine
Bodegas Terrazas De Los Andes Malbec Reserva 2004

[winelibrary...](#)

Web Results

Terrazas de los Andes
2009, 2008, 2007, 2006, 2005, 2004, 2003, 2002, 2001, 2000, 1999, 1998, 1997, 1996, 1995, 1994, 1993, 1992, 1991, 1990, 1989, 1988, 1987, 1986, 1985, 1984 ...
<http://www.terrazasdelosandes.com/>

Bodegas Terrazas de los Andes Winery
(Perdriel, Luján de Cuyo , AR ...)
Popular wines by **Bodegas Terrazas de los Andes**.

Mobile visual search: iPhone Apps



kooaba

Matched Image



Automotive safety

►► manufacturer products consumer products ◀◀

Our Vision. Your Safety.

rear looking camera forward looking camera side looking camera

EyeQ Vision on a Chip  [read more](#)

Vision Applications  Road, Vehicle, Pedestrian Protection and more [read more](#)

AWS Advance Warning System  [read more](#)

News

- Mobileye Advanced Technologies Power Volvo Cars World First Collision Warning With Auto Brake System
- Volvo: New Collision Warning with Auto Brake Helps Prevent Rear-end

[all news](#)

Events

- Mobileye at Equip Auto, Paris, France
- Mobileye at SEMA, Las Vegas, NV

[read more](#)

- Mobileye: Vision systems in high-end BMW, GM, Volvo models
 - “In mid 2010 Mobileye will launch a world's first application of full emergency braking for collision mitigation for pedestrians where vision is the key technology for detecting pedestrians.”

Source: A. Shashua, S. Seitz

Vision in supermarkets

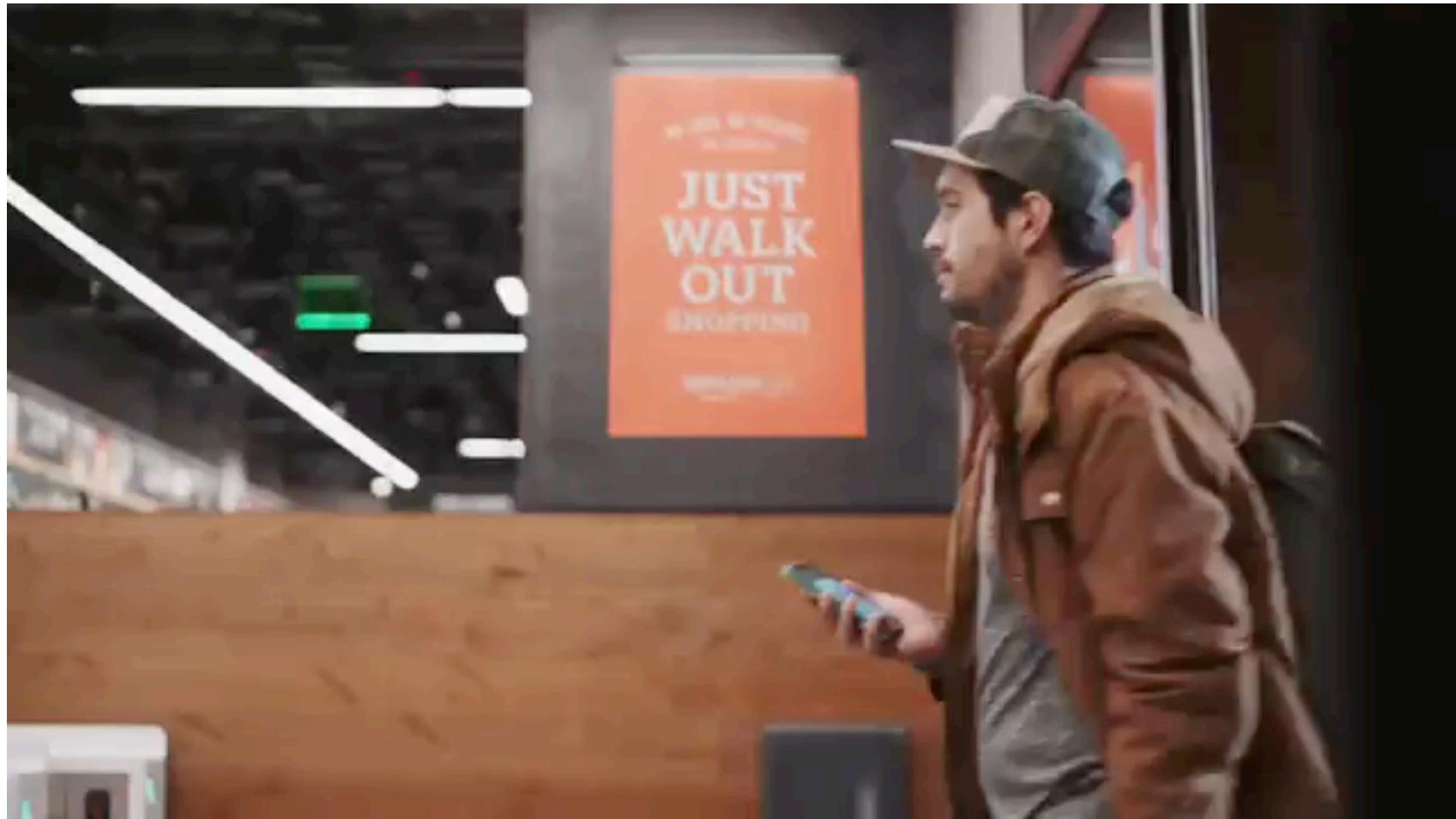


LaneHawk by EvolutionRobotics

“A smart camera is flush-mounted in the checkout lane, continuously watching for items. When an item is detected and recognized, the cashier verifies the quantity of items that were found under the basket, and continues to close the transaction. The item can remain under the basket, and with LaneHawk, you are assured to get paid for it...”

Source: S. Seitz

Amazon Go



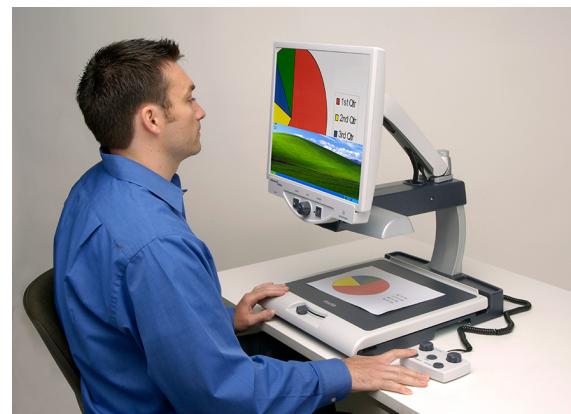
Vision-based interaction (and games)



Microsoft's Kinect



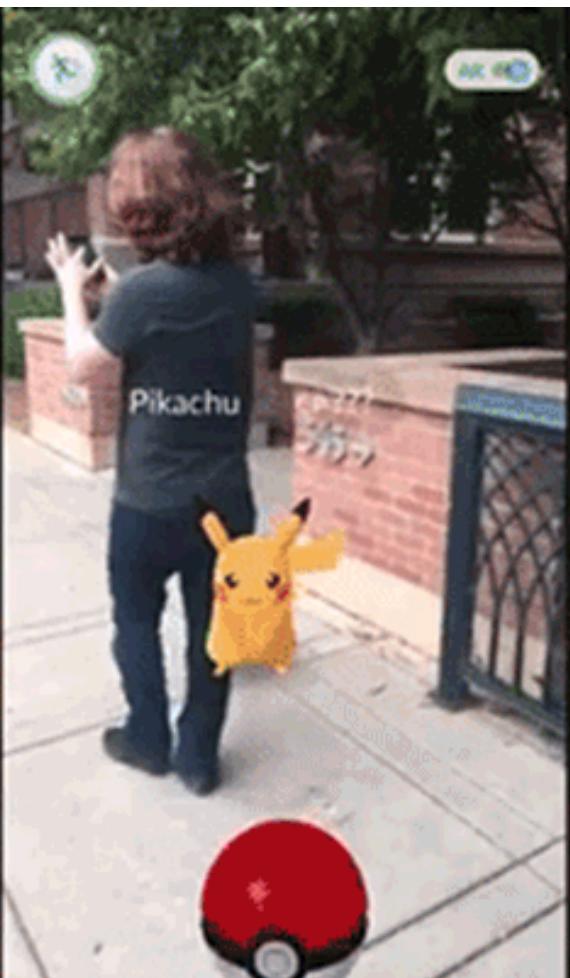
Sony EyeToy



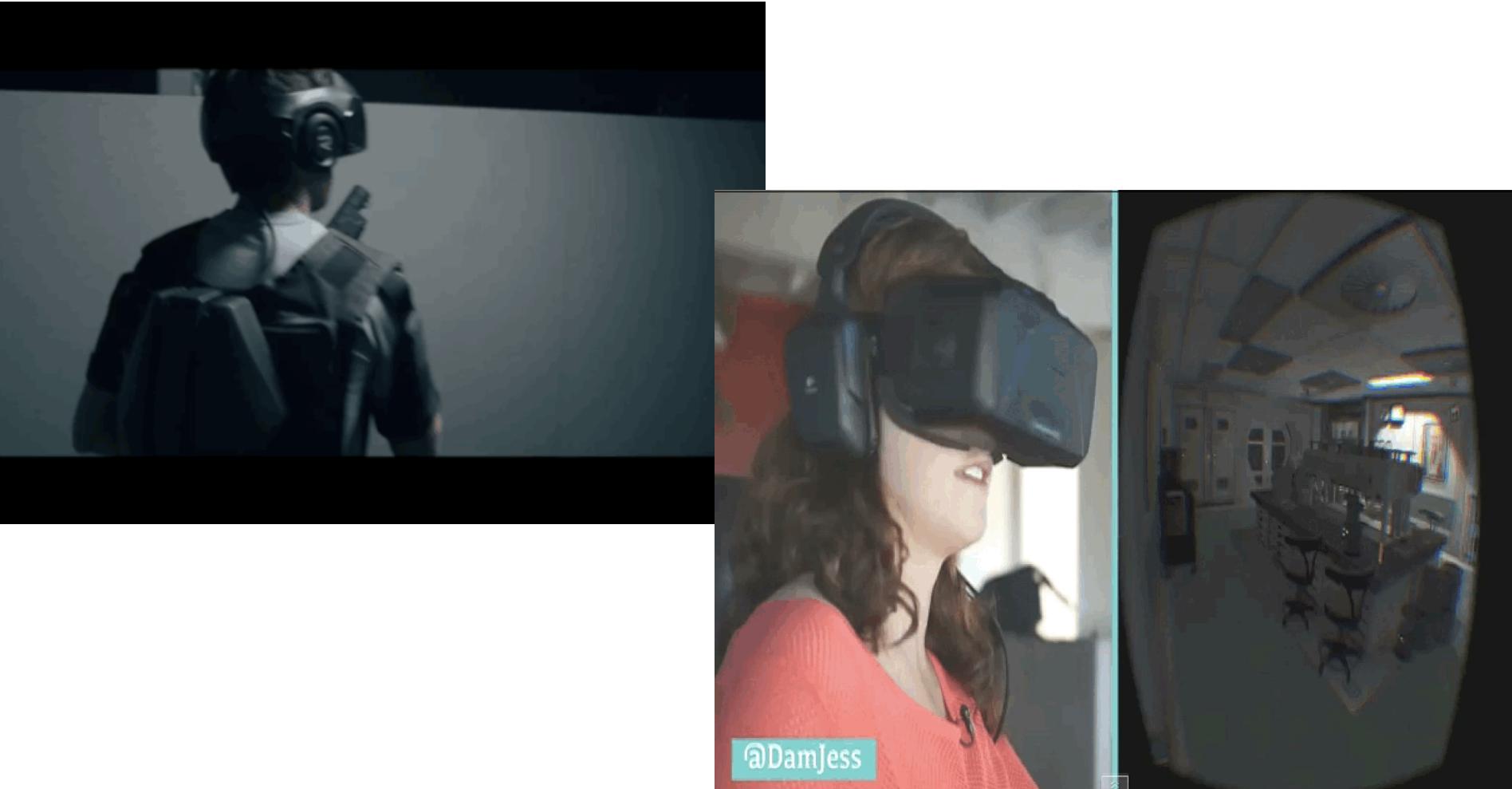
Assistive technologies

Source: S. Seitz

Augmented Reality



Virtual Reality



@DamJess

Vision for robotics, space exploration



[NASA'S Mars Exploration Rover Spirit](#) captured this westward view from atop a low plateau where Spirit spent the closing months of 2007.

Vision systems (JPL) used for several tasks

- Panorama stitching
- 3D terrain modeling
- Obstacle detection, position tracking
- For more, read “[Computer Vision on Mars](#)” by Matthies et al.